Be it known that Theodore R. Kucklick and Robert P. Bruce have invented a new and useful

Flexible Inflow/Outflow Cannula and Flexible Instrument Port

of which the following is a specification:

Field of the Inventions

The inventions described below relate the field of cannulas for use in surgical procedures and more particularly to a flexible instrument port for use during arthroscopic surgery.

Background of the Inventions

In arthroscopic surgery, it is common practice to fill the surgical site with clear saline solution (or other clear, inert fluid) in order to keep the field of view through an arthroscope clear. Since even a small amount of blood will cause the surgical site to become cloudy, means for draining and replenishing the irrigation solution are needed throughout the surgery.

For many arthroscopic surgeries, a rigid cannula is provided into the surgical site and is used to deliver irrigation fluid to the site. A tube is attached between the cannula and an elevated fluid reservoir is provided to deliver the fluid to the cannula. In this case, the rigid cannula is known as an inflow cannula. A second cannula or a suction device for draining fluid from the irrigation site is attached to one port of an arthroscope (or is provided separately). The arthroscope is then introduced into the surgical site. Fluid

from the fluid reservoir is introduced into the surgical site by opening a valve on the rigid cannula. Fluid then flows from the reservoir and into the surgical site, thereby irrigating the surgical site. Fluid is removed from the surgical site by activating the suction or by allowing fluid to drain through the second cannula on the arthroscope.

In another procedure, fluid can be introduced through the second cannula on the arthroscope and removed by means of the rigid cannula. In this case, fluid flows from the surgical site, through the rigid cannula, through a flexible plastic tube running from the cannula and to a waste fluid receptacle. In this method, the rigid cannula is referred to as an outflow cannula or as a drainage needle.

The rigid cannula can cause problems during the surgical procedure. During arthroscopic surgery, the surgeon often manipulates the patient's joint in order to obtain a different view of the joint or to accomplish some medical procedure. The arthroscope and rigid cannula often remain in the surgical site while the surgeon manipulates the joint. Manipulating the patient's joint with the rigid cannula in the operating site can cause significant problems. The rigid cannula can bruise or puncture soft tissue near the surgical site. In addition, the flow of fluid through the rigid cannula is frequently blocked by anatomical structures.

Devices and methods that address these problems have been described in Bruce, Flexible Inflow/Outflow Cannula, U.S. Patent 5,527,276 (Jun. 18, 1996). Bruce shows a flexible cannula that is increasingly more flexible towards the distal end of the cannula. When a surgeon manipulates a patient's joint while the Bruce cannula is in the joint, the Bruce cannula will bend as the joint bends. Thus, the Bruce cannula avoids the problems

associated with a rigid cannula. However, improvements in the Bruce cannula are possible.

Summary

The methods and devices described below provide for a cannula and instrument port for use during surgical procedures. The cannula is increasingly more flexible towards the distal end of the cannula. The thickness of the cannula is tapered towards the distal end of the cannula and slots are provided in the distal portion of the cannula to increase the flexibility of the distal portion of the cannula. The slots in the cannula are arrayed in rows, with each row disposed along a portion of the longitudinal length of the cannula. The rows are staggered with respect to each other, such that the rows are longitudinally offset from one another.

During a surgical procedure, an obturator or surgical instrument is inserted into the proximal end of the port and extends through the flexible cannula. Curved instruments can be used with the cannula since the distal end of the cannula will bend to conform to the shape of the instrument.

The instrument port also includes a duckbill valve, flapper valve or trumpet valve disposed in the proximal portion of the instrument port. The valve prevents fluid from flowing past the valve as instruments are inserted into and removed from the cannula. The instrument port is also provided with a fluid port to optionally drain fluid from or introduce fluid into the instrument port.

Brief Description of The Drawings

Figure 1 illustrates a flexible inflow/outflow cannula.

Figure 2 shows a longitudinal cross section of the flexible cannula taken along the line 2-2 shown in Figure 1.

Figure 3 shows a cross section of the flexible cannula taken along the line 3-3 shown in Figure 2.

Figure 4 is a perspective view illustrating the flexibility of the cannula shown in Figure 1.

Figure 5 is a perspective view of the cannula shown in Figure 1 with a valve and a surgical instrument disposed through the cannula.

Figure 6 illustrates a valve for use in the cannula shown in Figure 1.

Figure 7 shows an exploded view of an instrument port having a flexible distal cannula.

Figure 8 illustrates an instrument port having a flexible distal cannula and a bendable surgical clamp disposed within the cannula.

Figure 9 shows an instrument port having a flexible distal cannula and a proximal V-clamp integrally formed with a rigid tube.

Figures 9a, 9b and 9c illustrate alternative structures for the proximal clamp shown in Figure 9.

Figure 10 shows an instrument port having a flexible distal cannula and a proximal pinch clamp integrally formed with the rigid tube.

Figure 11 shows an instrument port configured with another pinch clamp.

Figure 12 shows an instrument port having a flexible distal cannula, a finger grip and a proximal stop-cock valve.

Figure 13 shows a cannula having differently sized slots.

Figure 14 shows a cannula having slots sized and dimensioned to allow fluid to flow into the cannula when the cannula is bent.

Figure 15 shows a partial longitudinal cross section of a cannula with a non-linearly tapered outer diameter.

Detailed Description of the Inventions

Figure 1 illustrates a flexible cannula 10 for use in delivering liquids to or from a surgical field during arthroscopic surgery. The cannula 10 comprises a stem 14, a distal end 18, a proximal end 22, a rigid tube 26 and an attachment means 30. A plurality of apertures 34 are positioned near the distal end 18 of the stem 14. The apertures may be provided with rounded edges to make inserting the cannula into an operating site easier.

Figure 2 illustrates that the cannula 10 is a hollow device having a lumen 38 that extends from the distal end 18 through the stem 14, and into the rigid tube 26. A lumen 39 extends from the proximal end 22, through the attachment means 30, and into the rigid tube 26. The cannula 10 has a total length "l" of approximately four inches.

The lumens 39 and 38 are open at the proximal end 22 and distal end 18, respectively, to provide a means for liquid to enter and exit the cannula 10. Additionally, the apertures, fenestrations or slots 34 extend through the stem 14 and into

the lumen 38, thereby providing a plurality of passageways for fluid to flow into or out of the lumen 38.

The stem 14, rigid tube 26 and attachment means 30 are most conveniently manufactured by injection molding from a polymeric material, such as high density polyethylene, to form a single piece instrument. The high density polyethylene sold by Dow Chemical Company under the designation Dow HDPE 25355N Resin (narrow molecular weight distribution copolymer) works quite well. Other materials compatible with use inside the human body and having the requisite flexibility could also be used to manufacture the cannula 10, and other fabrication techniques may be used to manufacture the cannula.

The rigid tube 10 includes an aperture 42 for accepting a valve 44 (shown in Figures 5 and 6) that controls the flow of fluid through the cannula 10 by providing a connection between the lumens 38 and 39. The attachment means 30 is a connector, such as a luer lock connector, which allows other pieces of equipment (e.g. fluid supply lines) to be attached to the cannula 10.

The stem 14 is an elongated structure extending from the rigid tube 26 to the distal end 18. Figure 3 illustrates that a cross section of the stem 14 is circular in shape.

In the cannula 10, the stem 14 is tapered along its length, meaning that the outside diameter of the stem 14 is greater at the proximal end of the stem 14 than it is at the distal end 18, and decreases smoothly from the proximal end of stem 14 to the distal end 18. In other words, the thickness of the cannula wall decreases along the distal length of the cannula. (As shown below, the cannula need not be tapered to retain the property of increasing flexibility towards the distal end of the cannula.)

For example, a cannula designed for arthroscopic surgery of the knee has the following dimensions: The outer diameter of the stem 14 at the reference line "a" is approximately 0.169 inches and the inner diameter at this line is approximately 0.119 inches. The outer diameter of the stem 14 at the distal end 18 is approximately 0.119 inches and the inner diameter at this point is approximately 0.090 inches.

Figure 4 illustrates that the flexible segment 46 has sufficient flexibility to bend through an angle (θ). The cannula shown in Figure 4 is thus useful during arthroscopic knee surgery. The thickness "t" of the stem 14 is about 0.025 inches at the reference line "a" and about 0.0145 inches at the distal end 18. This decrease in thickness of the stem 14 over the distance "f" results in the stem 14 becoming progressively more flexible as the distal end 18 is approached from the reference line "a." The increase in flexibility of the stem 14 is referred to as "progressive flexibility."

When the distance "f" is about 2.5 inches, the reference line "a" marks the region of the stem 14 where the stem 14 begins to bend when a person grasps the proximal end 22 in one hand and applies downward force to the distal end 18, using the other hand, sufficient to cause the stem 14 to bend through an angle (θ) of approximately ninety degrees. This force is comparable to what would be exerted by the knee while the knee is bent during arthroscopic surgery. Under these conditions, a rigid segment 50 of the stem 14 has sufficient thickness "t" so that it remains inflexible relative to the flexible segment 46. When the downward force is removed, the stem 14 returns to its original "straight" position.

Figure 5 illustrates the cannula 10 with the valve 44 positioned in the rigid tube 26. A surgical instrument 54 is

shown inserted in the lumen 38 of the cannula 10. The tip 58 of the instrument 54 extends outwardly from the distal end 18 of the cannula 10 while the proximal end of the instrument 54 is screwed over the attachment means 30, thereby firmly securing the instrument 54 inside the cannula 10.

Figure 6 illustrates that the valve 44 includes an aperture 62 that allows liquid to flow through the valve 46 when the valve 44 is open, thereby connecting the lumens 38 and 39. When the valve 46 is rotated such that the valve is closed, liquid can no longer pass through the aperture 62, thereby preventing liquid from flowing between the lumens 38 and 39.

When the knee is bent during a surgical procedure, the flexible segment 46 has sufficient flexibility to bend with the knee inside the compressed suprapatellar pouch. Because the stem 14 bends with knee, the flow of liquid into or out of the distal end 18 is not blocked. Additionally, since the stem 14 is flexible, there is much less likelihood that it will bruise or puncture tissue when the knee is bent.

Figure 7 shows an exploded view **100** of an instrument port **101** having a flexible distal cannula **102**. The instrument port is useful for many surgical procedures, including arthroscopic surgical procedures. The instrument port has a cylindrical rigid tube **103**, a duckbill valve **104** disposed proximally of the rigid tube and a flexible, tapered cannula **102** disposed distally of the rigid tube. The duckbill valve acts as a check valve which prevents fluids from flowing proximally through the valve while allowing an obturator **105** or other surgical instrument is inserted through the valve, into the rigid tube and through the cannula. The valve closes down upon the instrument and thus prevents substantial flow of fluids proximally through the valve. Thus, instruments may be inserted and removed as needed

without removing the flexible cannula from the operating area and without fluids flowing out of the valve. A fluid port or valve fitting **106** is provided in fluid communication with the rigid tube. The fluid port allows a surgeon to introduce or drain fluid to or from the operating site without withdrawing the instrument from the instrument port.

The flexible cannula is removably attached to the rigid tube, though the cannula may be fixedly attached to or integral with the rigid tube (or provided with a unitary construction). The cannula is tapered such that the cannula has increasing flexibility towards the distal end of the cannula. The outer surface of proximal portion **107** of the cannula is also corrugated or provided with ridges **108** to strengthen the cannula and decrease the flexibility of the proximal portion of the cannula. The ridges also help to prevent the cannula or instrument port from being unintentionally forced out of the operating field. The ridges are circumferentially disposed around the cannula (or extend radially from the tube.)

Apertures, fenestrations or slots **109** are disposed in the distal portion **110** of the cannula to allow fluid to flow into or out of the cannula lumen and also to increase the flexibility of the distal portion of the cannula. The slots are circumferentially oriented in the sense that the slots are narrow along the longitudinal length of the cannula, as compared to the circumferential width of the slots. The slots may be provided with rounded edges to decrease the chance that an instrument will snag against the edges of the slots.

The slots are disposed in longitudinal rows, with each row disposed along a longitudinal line of the cannula. The rows are longitudinally staggered with respect to each other in that the rows are longitudinally offset from one another. (The proximal

and distal edges of the slots in a particular row do not lie along the same circumferential line as the proximal and distal edges of the slots of the rows disposed to either side of the particular row.) The slots thereby form a zigzag pattern along the outer surface of the cannula, and the slots may be referred to as longitudinally staggered slots. (If the rows are all about parallel to each other and the slots are aligned with each other, then the slots also lie along circumferential lines.)

The longitudinally staggered slots relieve stress on the distal portion of the cannula when the cannula is bent. Thus, the longitudinally staggered slots increase the resistance of the cannula to kinking or collapsing. Kink resistance and collapse resistance may be further increased with braided fiber reinforcements in the flexible cannula. Similarly, the entire cannula may be reinforced with braided fibers. (The fibers increase the ability of a surgeon to transfer torque through the cannula.) Longitudinally staggered slots provide the additional benefits of high flexibility along two axes of bending and create large open arcs for superior fluid flow into and out of the cannula.

The flexible cannula is made of a soft plastic material having a durometer value of about 10 Shore A to about 45 Shore D. The cannula is provided with a blunt distal end **111** that is softer than the shaft **112** of the cannula. This, combined with the flexibility of the cannula, reduces the likelihood of accidental trauma to the patient during a surgical procedure. (The distal end may be sharp for other surgical procedures.) A low friction coating may be provided or applied to the outer surface of the cannula to further increase the ease of insertion into an operating site. For example, the cannula may be

provided with a Teflon® (expanded polytetrafluoroethylene or ePTFE) coating or covered with a water-activated lubricant.

. The cannula is compatible with radiofrequency surgical probes. The cannula is also thermally resistant so that electrical or thermal instruments may be operated through the cannula. In addition, the cannula may be made of an optically absorbing or scattering material so that laser light does not reflect from the cannula. The plastic cannula is also electrically non-conductive.

Figure 8 illustrates an instrument port **101** having a flexible distal cannula **102** and a bendable surgical clamp **120** disposed within the cannula. The instrument port includes a rigid tube **103**, a flexible cannula **102** attached to the rigid tube, a valve **106** attached to the rigid tube, and a duckbill valve **104** attached to the proximal portion of the rigid tube. The surgical clamp **120** has an instrument housing **121**, jaws **122** rotatably attached to the instrument housing and handles **123** for actuating the jaws. (The surgical clamp is shown to illustrate the use of the flexible cannula with a flexible instrument. Other flexible instruments may be used with this instrument port.)

Longitudinally oriented slots **124** in the cannula are disposed in the distal portion **110** of the cannula. (The slots are longitudinally oriented in that the longitudinal length of the slots is greater than the circumferential width of the slots). The slots are longitudinally staggered to increase the kink and collapse resistance of the cannula. The longitudinally oriented slots decrease the probability that a surgical instrument will snag on the edges of a slot. The slots may be provided with rounded edges to further decrease the chance that an instrument will snag against the edges of a slot.

Since the cannula is flexible, the instrument port is capable of accommodating curved, malleable or flexible instruments used during various surgical procedures. The portion shown in phantom shows that the cannula bends with the instrument. The cannula can bend along either axis **125** or **126.** However, the cannula can be made to bend preferentially along one of those two axes. For example, the cannula may be made wider along one axis, thus making the cannula preferentially bend in the direction of the other axis. Accordingly, the slots may be sized and dimensioned for preferential bending of the cannula.

In use, a surgeon inserts the surgical instrument into the instrument port, through the duckbill valve, through the rigid tube, and through the cannula. The surgeon then inserts the cannula and the instrument into the operating space. During the surgical procedure, the surgeon may introduce fluids into the operating space through the fluid port. Fluids flow through the fluid port, through the lumen in the rigid tube and cannula, and out of the slots and distal end of the cannula. Similarly, the surgeon can drain fluids from the operating space through the fluid port.

Figure 9 shows an instrument port **101** having a flexible distal cannula **102** and a proximal V-clamp **135** integrally formed with the rigid tube. The V-clamp, comprising a V-shaped or teardrop shaped opening **136** in a plate **137,** is attached to the rigid tube via an "L" brace **138.** The connection (shown at area **139**) between the rigid tube and the brace is thin enough, or the material flexible enough, that a person may move the brace and plate up and down with respect to the rigid tube, along the direction indicated by arrows **140.** A handle **141** may be provided to facilitate movement of the brace relative to a tube **142** or

instrument. Optionally, a tongue **143** extending proximally from the rigid tube supports the tube while the clamp clamps down on the tube. Preferably, the brace is made from a durable, resilient plastic or other substance that resists material fatigue while being bent. The brace may be manufactured to resiliently spring back to its originally manufactured position or it may be manufactured to hold a position to which it is bent (as set by the manufacturer).

In use, a tube **142** with flexible walls is secured in fluid communication with the instrument port. The tube is then pressed into the narrow end of the opening **136** in the plate **137**. Since the walls of the tube are flexible, the flow of fluid through the tube is restricted (thereby controlling the flow of fluid through the cannula). Fluid flow is restored by pushing the tube into the wide end of the opening in the plate, (by opening the lumen of the tube). In the case of inflexible tubes or solid instruments, the V-clamp can hold the tube or instrument in place with respect to the instrument port.

Figure 9a shows a second plate **137b** that can replace the plate shown in Figure 9. The opening **136** in the plate is hour-glass shaped, so that fluid flow is unrestricted when the tube is threaded through the first open end **150** or the second open end **151**. The tube is pinched closed when pushed into the narrow portion **152** of the opening.

Figure 9b shows a third plate **137c** that can replace the plate shown in Figure 9. The opening **136** in the plate is diamond-shaped, so that a tube is open to fluid when the tube is threaded through the center of the opening. The tube is pinched closed when pushed into the first narrow portion **153** or the second narrow portion **154** of the opening.

Figure 9c shows a fourth plate **137d** that can replace the plate shown in Figure 9. A tube **142** is pushed into the V-shaped opening **136** in the plate, thereby pinching the tube and limiting the flow of fluid through the tube. The tongue **143**, which can serve as a support for the tube, fits into teeth or ratchets **155** disposed along the edges of the slot. The tongue thus serves as a pawl, thereby securing the position of the tongue with respect to the tube. The tongue also pinches the bottom of the tube as the tongue is ratcheted closer to the V-shaped slot. In addition to the plates shown in Figures 9a through 9c, other configurations can be used so long as a tube threaded through the opening in the plate can be moved to pinch the tube closed in one position and leave the tube open to fluid flow in another position.

Figure 10 shows an instrument port **101** having a flexible distal cannula **102** and a proximal pinch clamp **160**. The pinch clamp comprises two "L" braces **161** extending from the rigid tube **103** in the same manner as described in reference to Figure 9. The braces are flexible with respect to the rigid tube so that the braces may move up and down (along arrows **162**) with respect to the rigid tube. Integrally formed with the braces are inwardly extending anvils **163**, which in Figure 10 are inwardly extending hollow wedges. (The anvils may have different shapes and dimensions.) When the braces are pinched together, the anvils pinch the tube which passes between the anvils.

To hold the pinch clamp in a closed position, a ratchet **164** is disposed at the proximal end of one of the braces. The end **165** of the other brace serves as a pawl that fits into the teeth **166** of the ratchet, thereby holding the clamp closed against the force that causes the braces to spring back into their original

positions. (The braces are resiliently biased to spring back into their original positions.)

In use, a tube **142** with flexible walls or a rigid instrument is inserted through the clamp and the clamp can serve to hold an instrument in place or control fluid flow through a flexible tube. The braces are pressed together so that the anvils pinch the tube or instrument, thereby restricting the flow of fluid or holding the instrument in place. The end of one of the braces fits into the teeth of the ratchet, thereby holding the pinch clamp in a particular position.

Figure 11 shows an instrument port **101** configured with another pinch clamp **160**. Like the pinch clamp shown in Figure 10, the braces **161** extend from the rigid tube and are bendable with respect to the rigid tube **103** along the direction of arrows **167**. However, in this case the braces are curved so that the proximal portion **168** of the braces are "S" shaped. In use, the two "S" shaped portions of the braces are clamped together and fit snugly together. When clamped together, a tube **142** disposed between the braces is pinched and the flow of fluid through the tube is restricted. Since the braces fit snugly together, the braces remain together until separated.

The instrument port may be provided with additional features. For example, Figure 12 shows an instrument port **101** having a flexible distal cannula **102**, a finger grip **180** and a proximal stop-cock valve **181**. An obturator **105** or other instrument is disposed through the rigid tube and cannula. The rigid tube is ergonomically shaped into a finger grip so that a surgeon may securely and easily grip the rigid tube and manipulate the instrument port. The stop-cock valve is operable to seal off the flow of fluid to or from the instrument port.

In another example, Figure 13 shows a cannula **102** having differently sized slots **109.** The differently sized slots change how the flexible cannula bends. In the cannula shown in Figure 13, the slots increase in distal-proximal width towards the distal end **111** of the cannula. In other embodiments the slots may increase in radial depth, or both in width and depth, to accomplish the same effect. In each case, the cannula becomes increasingly more flexible towards the distal end as compared to the flexible cannula shown in Figures 1 through 6. In other words, the center of curvature of the cannula (as the cannula is bent from the distal end) is advanced distally with the cannula of Figure 13 as compared to the cannula of Figures 1 through 6. Thus, the way in which the cannula bends may be adjusted by changing the proximal-distal width or the radial depth of the slots.

Figure 14 shows a cannula **102** having slots **109** that allow fluid to flow into and out of the cannula even if the cannula is bent at an angle. The slots are provided with rounded heads **182** disposed at either end of a given slot. If the cannula is bent at a large angle, and if the rounded heads are not provided at the ends of each slot, then a narrow slot may be pinch closed; thus, fluid will not flow into the cannula. However, the larger openings at either end of each slot will remain open even if a given slot is pinched closed, thereby allowing fluid to flow into the cannula.

The cannula may be made increasingly more flexible towards the distal end by other methods. For example, Figure 15 shows a partial cross section of a cannula **102** that has an outer diameter which is tapered to create a non-linear shape along the proximal-distal length of the cannula. In this case, the outer diameter of the cannula varies to create a parabolic shape along

proximal-distal length of the outer surface of the cannula, as shown in Figure 15. In other words, the outer surface **183** of the distal portion **110** of the cannula traces a parabolic path from the ridges **108** to the distal end **111** of the cannula. The inside walls **184** of the lumen remain straight and smooth. This cannula may be referred to as a parabolically tapered cannula. The cannula shown in Figure 15 is not provided with slots, though it is still increasingly flexible along its distal length due to the tapering of the cannula.

The cannula may be differently tapered to form other shapes, so long as the radial thickness of the cannula decreases towards the distal end of the cannula or so long as some other means is provided for making the distal portion of the cannula more flexible than the proximal portion (such as via slots). Another method is to put long, longitudinal grooves (bayonet grooves) along the outer surface of the cannula. Slots may be placed in the grooves to increase the flexibility of the distal portion of the cannula. Slotted grooves also allow fluid to flow into and out of the cannula even if the cannula is pressed against tissue. (The grooves prevent tissue from pressing against the slots and blocking the slots.)

Another method of making the cannula increasingly flexible towards the distal end of the cannula is to provide a number of circumferential grooves that are disposed in the distal portion of the cannula and spaced along the longitudinal length of the cannula. In other words, a number of circumferential sections of the wall of the cannula are provided with a thickness that is less than the thickness of the circumferential wall sections just proximal and just distal of a particular thinner section. For example, one or more circumferential grooves may be placed between any two slots in a particular row of slots (though

grooves also may be placed proximally or distally of the rows of slots). Where the rows of slots are about parallel to each other and the slots are longitudinally aligned with each other, the circumferential grooves may extend around the entire circumference of the cannula to further increase the flexibility of the distal end of the cannula.

The instrument port or inflow/outflow cannula may be further modified to meet different surgical needs. For example, the flexible cannula may be fashioned as an integral whole. (The embodiment in Figures 7 and 8 shows a removably attached flexible cannula, resulting in a modular device.) In addition, with respect to the valve, valves other than the duckbill valve may be used. Optional valves include a trumpet valve, an elastic ring valve, a flapper valve, a stopcock valve, a clamp valve or other type of valve that seals gas or fluid into a surgical space or allows the passage of a surgical instrument into the surgical space.

In addition, the instrument port's rigid tube and cannula may be provided with different cross sections to change how the cannula bends and to accommodate differently shaped instruments. For example, a cannula having an elliptical cross section is preferentially flexible on its minor axis. This cannula also accommodates instruments having a flat, narrow shape.

The cannula, or one or more of the instrument port components, may be modified to assist medical personnel during a procedure. For example, the cannula or one or more of the instrument port components may be provided with a deflecting mechanism, such as one or more pull wires. Thus, a surgeon will be able to guide the cannula or instrument port more easily during a surgical procedure. To further aid the surgeon, the cannula may be made of a memory material designed to return to

its manufactured shape. The cannula may also be made of a material that is malleable. Such a device could be bent into a curved shape.

Yet another cannula or instrument port may be radio opaque so that the surgeon can determine the location of the cannula during a procedure. Similarly, the cannula may have radio opaque markings which indicate a measurement of distance, depth of penetration, degree of deflection or orientation of the device within an operating space. (The radiopaque or radiolucent cannula is particularly useful during hip arthroscopy.) The cannula or instrument port may be transparent so that sutures, specimens or instruments disposed inside the cannula can be visualized within the cannula.

The instrument port V-clamp and pinch clamp may be provided in a variety of shapes and sizes, so long as the clamp is operable to secure an instrument or restrict the flow of fluid within a flexible tube. For example, the "L" brace may be replaced with differently shaped braces and the plate may have different sizes and shapes. The opening in the plate may vary to accommodate differently sized tubes or instruments. Furthermore, the brace and the port may be operably connected by a hinge or a pivot/peg system instead of by a thin section of the brace. In the case of the pinch clamp, the pinch clamp may be secured by a latch, hook or other means for securing the pinch clamp, instead of by the ratchet and pawl system shown in Figure 10. Similarly, the ratchet, pawl, "L" braces and anvils of the pinch clamp may have different sizes and dimensions, so long as the pinch clamp can secure an instrument or restrict the flow of fluid within a flexible tube. In addition, other types of pinch clamps may be used.

The instrument port or its cannula may be specifically designed to accommodate different instruments. For example, the instrument port may be provided with an adjacent accessory port to accommodate a fiber optic, LED or laser lights source. Furthermore, the cannula may be made of an optically conducting material, whereby the cannula itself acts as a light pipe. Other instruments for which the accessory instrument port may be designed include trocars, obturators, scalpels, clamps, electrodes or other instruments. The instrument port may be designed to accommodate multiple instruments; for example, by providing the instrument port and cannula with multiple lumens. In each case, the instrument port accommodates the features of the particular instrument; for example, the instrument port may be provided with extra ports in the rigid tube to accommodate cables or wires used with a particular instrument. In addition, other clamps may be used to restrict the flow of fluid through a flexible tube or to hold an instrument place. For example, an inline roller clamp on the tube or instrument may be used. Thus, while the preferred embodiments of the devices and methods have been described in reference to the environment in which they were developed, they are merely illustrative of the principles of the inventions. Other embodiments and configurations may be devised without departing from the spirit of the inventions and the scope of the appended claims.